

FAECES DETERIORATION RATES OF FOUR WILD UNGULATES IN THAILAND

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SUMMARY

Faeces deterioration rates were higher in the rainy season than in the dry season by 4 to 6 times for Asiatic elephant (*Elephas maximus*), 1.25 to 2 times for sambar deer (*Cervus unicolor*) and 1 to 2 times for banteng (*Bos javanicus*) and gaur (*Bos gaurus*). Recommended maximum intervals between plot checks in dropping count censuses of elephant are 100 days and 40 days for the dry and rainy seasons, respectively, and 60 days in the dry season and 30 days in the rainy season for sambar. The method is questionable for use with banteng and gaur. Factors affecting rates are discussed.

INTRODUCTION

With the increasing interest in properly managing and maintaining Thailand's dwindling wildlife resources, development of accurate census techniques is a necessity. Future research work performed in established wildlife sanctuaries and national parks and the recently proposed "Elephant Ranges" (LEKAGUL & MCNEELY, 1977) will require some method of detecting and warning of further declines in populations. Effective censusing will do this plus provide much of the basic ecological information still missing for the region's wildlife.

Census methods may be either of two basic types. Direct censusing techniques depend on direct sightings to determine abundance while indirect censusing techniques use only the evidence of an animal's presence, such as its droppings, tracks and feeding signs. Because of the denseness of the forest and elusive behaviour of most large mammals, direct censusing is generally impractical for most locations in South-East Asia. Indirect censusing techniques allow the measuring of abundance, habitat preferences and seasonal changes in habitat use and avoid the problems caused by thick vegetation and the nocturnal behaviour and extreme wariness of the species. The pellet group or dropping count census is the most common method of

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indirect censusing. If a constant faeces defecation rate is assumed and the length of the deposition period is known, population size can be estimated by finding the number of droppings per unit of sample area and extrapolating to cover a larger but still representative area. It is still relatively new and untried for southern Asia and will require much experimentation before being put to practical use.

This study was designed to measure one of the basic but variable aspects of faeces count censusing, that of dropping deterioration rates. Rates were measured for Asiatic elephant, sambar deer, banteng and gaur in south-western Thailand at Salak Phra Wildlife Sanctuary. Decay rates have long been assumed to be quite rapid in the tropics and subtropics; however, there have been few studies made to prove this. The purposes of the project were to determine whether deterioration rates were slow enough to make dropping counts feasible and to give recommendations on time intervals between field checks of sample plots.

STUDY AREA

Salak Phra Wildlife Sanctuary is located among the eastern-most foothills of the Tenasserim Mountains in Kanchanaburi Province in south-western Thailand. The area, which was designated a sanctuary in 1972, is situated on the eastern bank of the Mae Klong or Khwae Yai River (14°08' to 14°42' N and 99°06' to 99°25' E) and has a total area of 936 km². Steep limestone hills alternating with several valleys of 25 to 50 km² dominate the landscape. Elevations range from 55 to 1210 m. Some of Thailand's finest bamboo forest is also present. On the North-West side, the sanctuary borders a reservoir behind the newly completed Chao Nen Dam and its associated village resettlement areas. To the South-West, south and east, scrub bamboo forest and cultivated land planted mostly to sugar cane border the reserve. Only in the north does relatively undisturbed forest continue outside the sanctuary boundaries.

MOORMAN & RAJANASOONTHON (1972) distinguish two soil types for this part of Kanchanaburi. Red-brown earths exist in the lowlands, where they have originated from limestone residuum or from alluvial and colluvial deposits derived from limestone. The soil is generally clayey in texture but clay is especially evident in the B horizon where base saturation is medium

to high. The second soil type, found on hills and steep terrain, is variable in character but is always very shallow and frequently similar to the lowland red-brown earths.

The climate at Salak Phra is characterized by three basic monsoonal seasons typical of Thailand. A rainy season occurs from May to October when approximately 75% of the annual rainfall occurs, a cool, dry season from November to February, and a hot, dry season from February to May. As is typical for western Thailand, lying in the rainshadow of the Tenasserim Mountains, average annual rainfall is low at 1130 mm (Figure 1). Average maximum air temperature is 32.5°C with an average minimum of 20.1°C (Figure 2). Weather data were collected at Amphoe Si Sawat, a town 45 km North-West of the study area.

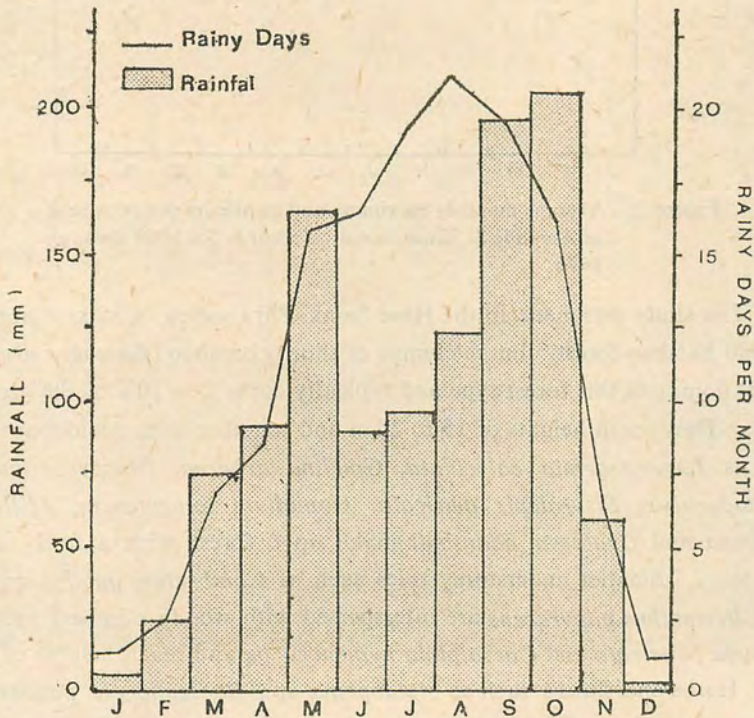


Figure 1. Average monthly rainfall and average number of rainy days per month at Amphoe Si Sawat based on records for 1969 through 1976.

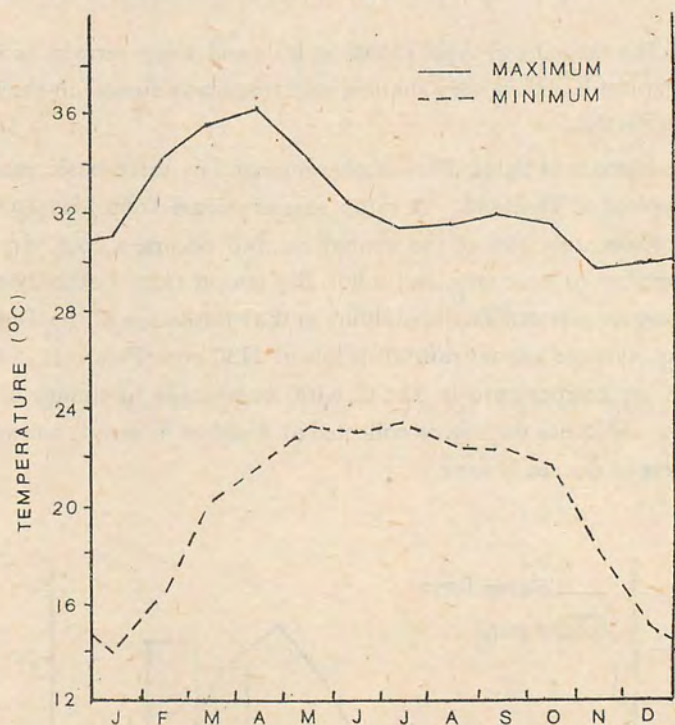


Figure 2. Average monthly maximum and minimum temperatures at Amphoe Si Sawat based on records for 1969 through 1976.

The study was made in the Huai Salak Phra valley, a 35 km² area of lowland bamboo forest. Large clumps of thorny bamboo (*Bambusa arundinacea*) dominate this forest type and typically cover 2 to 10% of the ground space. They reach heights of 15 to 25 m and together with deciduous trees such as *Lagerstroemia calyculata*, *Gmelina arborea*, *Diospyros mollis*, *D. rhodocalyx*, *Sisyrrolepis muricata*, *Homalium tomentosum*, *Millettia leucantha* and *Crataeva adansonii* make up a forest with a fairly open overstorey. Smaller understorey trees such as *Combretum quadrangulare* and *Cleistanthus papyraceus* are interspersed with woody climbers such as *Bauhinia bracteata* and *Caesalpinia hymenocarpa* and reach heights of 4 to 8 m. Herbs and shrubs such as *Aglaonema* sp., *Boesenbergia pandurata*, *Bauhinia scandens*, *Grewia tomentosa*, *Harrisonia perforata*, *Streblus asper* and *Glyphostylus laoticus* make up a low density, typically thorny ground cover. Associated soils are very thick.

Upland bamboo forest is found on the hillsides and upland areas surrounding the valley. *Thyrsostachys siamensis* replaces *Bambusa arundinacea* as the dominant plant species while many of the tree, shrub and herb species found in the lowland bamboo forest remain but at a lower density. The deciduous tree canopy reaches 12 to 20 m but is very open while *T. siamensis* forms a solid layer in the 7 to 15 m strata throughout and at times almost forms a pure stand. Rock outcrops are frequent and the soil layer is thin. No ecotone exists between the upland and lowland bamboo forests, and the line separating them is easily visible. Other forest types found in the sanctuary but not in the study area are dry dipterocarp forest and scrub bamboo forest.

METHODS

Between August 1976 and October 1977, elephant, banteng, gaur and sambar deer droppings were located, measured and marked. They were subsequently revisited and rated at intervals ranging from 10 to 18 days. Results were interpolated to fit 10-day age classes. Only droppings less than 7 days old when found and accurately aged to within a day were used in the study. Most were left at their original drop site but a few, particularly sambar pellet groups, were moved to similar but more convenient study locations.

The rating system used on elephant, banteng and gaur droppings was developed by WING & BUSS (1970) in their study of African elephants (*Loxodonta africana*) in Uganda. They rated faeces as being in one of the following classes:

Easily Recognized. Little noticeable deterioration. Boluses remaining essentially intact and identification of dropping easy.

Recognizable. Extensive decomposition, erosion, settling and rearrangement of faecal materials may have occurred, but sufficient concentration of materials remain to definitely identify the dropping.

Barely Recognizable. Decomposition and removal of dropping materials so extensive that only with care and examination of indirect evidence can the remaining materials be identified as components of an elephant dropping.

Not Recognizable (Gone). The removal or decomposition of faecal material so complete that identification as an elephant dropping no longer possible.

Two classes were altered slightly by me to include the following distinction :

Recognizable. Definitely recognizable by an experienced worker during a field count.

Barely Recognizable. May fail to be recognized by an experienced worker during a field count.

Because of the difficulty in distinguishing gaur and banteng droppings from one another, they were combined into a single grouping and assumed to be the same. Banteng were much more common in the area and their droppings certainly made up the largest portion of the total.

A different system considered to be more sensitive to pellet disappearance was used for classifying the pellet groups of sambar deer. Pellets within a group did not always deteriorate at equal rates. Characteristically, groups contained pellets ranging through the three classes of recognizability plus some that had already disappeared. Individual pellets often remained in an Easily Recognizable or Recognizable condition until they initially broke apart. Rapid deterioration followed this during which time the pellet could briefly be rated as Barely Recognizable before disappearing completely. Thus, the number of pellets rated as at least Recognizable was counted per group at each visit to give the percentage left from the number of pellets originally found. Classes of 100 to 71%, 70 to 41%, 40 to 11%, 10 to 1% and Gone were used.

RESULTS AND DISCUSSION

Deterioration rates were determined for 133 elephant, 86 wild cattle and 57 sambar deer droppings or pellet groups. The rates presented in the tables are percentages taken from the number of droppings in each age class. The shrinking sample primarily reflects that the study ended before all droppings could be rated through a standard time span. This was particularly important in causing the small rainy season samples for sambar, banteng and gaur. Other reasons for droppings to be eliminated were their destruction by elephant disturbance and loss due to fire and water flow through normally dry stream beds. No attempts were made to compare decay rate differences

Table 1. Deterioration rates for elephant droppings as percentages of droppings per sample.

No. of days exposed	Combined yearly rates					Dry season rates					Rainy season rates				
	No. of drop-pings	ER	Rec	BR	NR or Gone	No. of drop-pings	ER	Rec	BR	NR or Gone	No. of drop-pings	ER	Rec	BR	NR or Gone
10	133	67.7	30.8	1.5	0	92	78.3	21.7	0	0	41	43.9	51.2	4.9	0
20	133	65.4	33.1	1.5	0	92	77.2	22.8	0	0	41	39.0	56.1	4.9	0
30	133	49.6	48.9	1.5	0	92	60.9	39.1	0	0	41	24.4	70.7	4.9	0
40	133	43.6	54.1	2.3	0	92	54.3	45.7	0	0	41	19.5	73.2	7.3	0
50	131	35.1	58.8	6.1	0	90	44.4	52.2	3.3	0	41	14.6	73.2	12.2	0
60	131	27.5	65.6	6.1	0.7	90	36.7	60.0	2.2	1.1	41	7.3	78.0	14.6	0
70	127	23.6	67.7	7.1	1.6	87	31.0	65.5	2.3	1.1	40	7.5	72.5	17.5	2.5
80	122	22.1	67.2	9.0	1.6	82	29.3	67.1	2.4	1.2	40	7.5	67.5	22.5	2.5
90	116	19.0	67.2	9.5	4.3	79	25.3	69.6	3.8	1.3	37	5.4	62.2	21.6	10.8
100	115	15.7	69.6	9.6	5.2	79	21.5	72.2	3.8	2.5	36	2.8	63.9	22.2	11.1
110	110	13.6	64.5	15.5	6.4	79	19.0	72.2	5.1	3.8	31	0	45.2	41.9	12.0
120	104	13.4	62.5	16.3	7.7	79	17.7	70.9	6.3	5.1	25	0	36.0	48.0	16.0
130	102	12.7	59.8	17.6	9.8	79	16.5	68.4	7.6	7.6	23	0	30.4	52.2	17.4
140	100	9.0	59.0	19.0	13.0	77	11.7	67.5	10.4	10.4	23	0	30.4	47.8	21.8
150	80	8.8	52.5	21.3	17.5	57	12.3	63.2	10.5	14.4	23	0	26.1	47.8	26.1
160	68	10.3	45.6	25.0	19.1	45	15.6	56.6	15.6	13.3	23	0	26.1	43.4	30.4
170	67	6.0	44.8	23.9	25.4	44	9.1	54.5	15.9	20.5	23	0	26.1	39.1	34.8
180	67	4.5	46.3	20.0	28.4	44	6.8	56.8	13.6	22.7	23	0	26.1	34.8	39.1
210	48	2.1	47.9	14.6	35.4										
240	48	0	43.8	18.8	37.5										
270	48	0	41.7	12.5	45.8										
300	36	0	27.8	19.4	52.8										
330	26	0	26.9	11.5	61.5										
360	21	0	23.8	4.8	71.4										
390	21	0	19.0	4.8	76.2										

ER = Easily Recognized

Rec = Recognizable

BR = Barely Recognizable

NR = Not Recognizable

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due to variance in habitat type, shade or dropping composition because all but 2.4% of the droppings and pellet groups came from a 2-km² section of lowland bamboo forest. Variance in these conditions was relatively minimal at any one time among most droppings.

Elephants. The results for elephant dropping deterioration rates are presented in Table 1. Droppings in the categories Easily Recognized and Recognizable would be found in all cases by an experienced observer during a hypothetical dropping count survey. However, many of those rated as Barely Recognizable and all rated as Not Recognizable would not be found. Thus, the columns of Easily Recognized and Recognizable could be combined into a single class of droppings that would be visible in the field while the Barely Recognizable and Not Recognizable columns would form a class not visible during a survey. Results show that deterioration rates are 4 to 6 times higher in the rainy season than in the dry season. Nearly all droppings from the dry season are identifiable for at least the first 110 days while more than 60% are still identifiable after 180 days. In comparison, most droppings from the rainy season remain identifiable for at least 40 days with only 26.1% recognizable past 180 days. No dropping completely disappeared within its first 50 days during any time of the year. Dry season deterioration rates reported by WING & BUSS (1970) for African elephants were higher. Most of their droppings remained recognizable through 20 days with only 2.4% recognizable past 150 days. Some disappeared within 15 days. This higher deterioration rate may have been caused by a large percentage of droppings coming from grassland where decay rates are higher than in forest (WING & BUSS 1970), a greater occurrence of dung beetles, a higher rainfall of 1475 mm per year, a slightly different interpretation of the recognizability classes, or a difference in diet. In Salak Phra, elephant diets contained a high percentage of bamboo leaves and culms while in the Ugandan study, the diet was mostly grass with some woody material. WING & BUSS (1970) also mention seeds inside droppings often germinate and can reach heights of 60 cm within two months' time. Aside from occasional fungal growth, this was never found at Salak Phra. Diameter was measured for 87 intact droppings (Table 2) and averaged 11.71 cm per bolus. Unfortunately, these measurements could not be related to an age class of elephant.

Banteng and Gaur. The deterioration rates for banteng and gaur droppings (Table 3) may be interpreted by the same method used for elephant (Table 1). Although droppings for the two bovine species were assumed to be the same, small differences in diet or size may have produced slightly different deterioration rates. Definite comparisons between seasons are difficult to make due to the small sample size in the rainy season. However, it appears that through the first 50 days, decay rates during the rainy season are 1.5 to 2 times higher than in the dry season. Through the next 100 days, they become roughly equal. In both seasons, at the end of the first 10 day period, more than 10% of all cattle faeces are already barely recognizable or have completely disappeared. Only 15% of the dry season droppings remain recognizable after 150 days but no dropping from the rainy season is recognizable past 120 days. Cattle faeces deteriorate much faster than elephant droppings because of their higher water content which provides bacteria, fungi and insects with ample moisture year round (EISENBERG *et al.* 1970) and because they contain more finely digested material which breaks down more quickly. Measurements were taken from 72 banteng and gaur droppings (Table 2). Average area per pile was 727.5 cm² with the average volume being 2494.4 cm³. This would produce a typical circular dropping with a diameter of 30.4 cm and a height of 3.43 cm.

Table 2. Measurements from 87 elephant droppings and 72 banteng and gaur droppings.

elephant		banteng and gaur			
diameter of bolus		area of dropping		volume of dropping	
size class		size class		size class	
(cm)	%	(cm ²)	%	(cm ³)	%
5.25	1.2	150- 350	13.9	300-1100	9.7
6.50	1.2	351- 550	20.8	1101-1900	29.2
7.75	6.9	551- 750	25.0	1901-2700	30.6
9.00	9.2	751- 950	23.6	2701-3500	12.5
10.25	12.6	951-1150	4.2	3501-4300	5.6
11.50	14.9	1151-1350	2.8	4301-5100	2.8
12.75	21.8	1351-1550	4.2	5101-5900	6.9
14.00	24.1	1551-1750	2.8	5901-6700	1.4
15.25	5.7	1751-1950	2.8	6701-7500	1.4
16.50	2.3				
Average = 11.71 cm		Average = 727.5 cm ²		Average = 2494.4 cm ³	

Table 3. Deterioration rates for banteng and gaur droppings as percentages of droppings per sample.

130

No. of days exposed	Combined yearly rates					Dry season rates					Rainy season rates				
	No. of drop-pings	ER	Rec	BR	NR or Gone	No. of drop-pings	ER	Rec	BR	NR or Gone	No. of drop-pings	ER	Rec	BR	NR or Gone
10	86	40.7	47.7	8.1	3.5	66	33.3	56.1	6.1	4.5	20	65.0	20.0	15.0	0
20	86	27.9	57.0	10.5	4.7	66	24.2	63.6	7.6	4.5	20	40.0	35.0	20.0	5.0
30	85	16.5	60.0	18.8	4.7	65	12.3	66.2	16.9	4.6	20	30.0	40.0	25.0	5.0
40	85	7.1	56.5	27.1	9.4	65	7.7	58.5	26.2	7.7	20	5.0	50.0	30.0	15.5
50	81	6.2	49.4	30.9	13.6	63	7.9	49.2	31.8	11.1	18	0	50.0	27.8	22.2
60	80	6.2	47.5	31.3	15.0	62	8.1	46.8	32.3	12.9	18	0	50.0	27.8	22.2
70	77	5.2	44.2	28.6	22.1	59	6.8	44.1	27.1	22.0	18	0	44.4	33.3	22.2
80	74	2.7	43.2	27.0	27.0	59	3.4	40.7	32.2	23.7	15	0	53.3	6.7	40.0
90	74	1.4	40.5	24.3	33.8	59	1.7	39.0	27.1	32.2	15	0	46.7	13.3	40.0
100	74	1.4	31.1	31.1	36.5	59	1.7	28.8	37.3	32.2	15	0	40.0	6.7	53.3
110	74	0	29.7	32.4	37.8	59	0	27.1	39.0	33.9	15	0	40.0	6.7	53.3
120	72	0	18.1	38.9	43.1	59	0	16.9	44.1	39.0	13	0	23.1	15.4	61.5
130	65	0	13.8	40.0	46.2	59	0	15.3	42.4	42.4	6	0	0	16.7	83.3
140	65	0	13.8	40.0	46.2	59	0	15.3	42.4	42.4	6	0	0	16.7	83.3
150	65	0	13.8	35.4	50.8	59	0	15.3	37.3	47.5	6	0	0	16.7	83.3
160	65	0	12.3	35.4	52.3										
170	65	0	12.3	30.8	56.9										
180	65	0	12.3	29.2	58.5										
210	64	0	4.7	26.6	68.8										
240	57	0	5.3	22.8	71.9										
270	57	0	5.3	10.5	84.2										
300	57	0	0	5.3	94.7										
330	57	0	0	3.5	96.5										

W/15E

ER = Easily Recognized

Rec = Recognizable

BR = Barely Recognizable

NR = Not Recognizable

Sambar Deer. For sambar deer pellets, groups in the three categories ranging from 11 to 100% were considered visible under survey conditions while groups in the 1 to 10% and Gone categories would not be visible (Table 4). Again, accurate comparisons between seasons are difficult to make because of the low sample size from the rainy season. Generally, it appears that for the initial 60 days, deterioration rates for the rainy season are twice as high as for the dry season. Through the next 60 days, rainy season rates drop to between 1.25 and 1.5 times higher and then through the final 150 days are again doubled. Almost 90% of all groups are still identifiable through their first two months in the dry season and 67.3% recognizable after 270 days. In contrast, only 85.7% of all groups remained after their first 30 day period in the rainy season and only 30% were visible after 270 days. All other studies on persistence of deer pellet groups have taken place in temperate regions. VAN ETEN & BENNETT (1965) found deterioration to vary with habitat type, soil conditions and time of year in Michigan, U.S.A. For pellet groups of white-tailed deer (*Odocoileus virginianus*) in hardwood forest with some light penetration and dry soil and deposited in the winter, about 57% were present after 15 months and 28% after 27 months. For summer deposited groups, 83% were still present after 90 days and 28% after 270 days (VAN ETEN & BENNETT 1965). J. B. LOW (1959, unpublished report, Utah Coop. Wildl. Research Unit) found 93.1% of all deer pellet groups were recognizable after three years and 65.5% after four years in Utah, U.S.A., an area of low rainfall and humidity.

Decay Agents. Other than the slow processes of weathering and decomposition, no principal factor was consistently involved in the deterioration of faeces. Ant and termite activity was present in many elephant and some cattle and sambar deer droppings. They played a large role in the process of replacing faecal material with soil. Dung beetle activity was found occasionally in cattle droppings and sambar pellet groups and dramatically increased deterioration rates when present. They caused some pellet groups to disappear within one month. Their levels were much lower than those found by WING & BUSS (1970), who considered dung beetle activity to be the main cause of elephant dropping decay, and DOWNING *et al.* (1965), whose white-tailed deer population estimates made by pellet group counts in Georgia, U.S.A., dropped by 75 to 80% during the dung beetle season. Beetle

Table. 4 Deterioration rates for sambar deer pellet groups as percentages of groups per sample.

No. of days exposed	Combined yearly rates						Dry season rates						Rainy season rates					
	Percent of pellets left						Percent of pellets left						Percent of pellets left					
	No. of groups	100- 71%	70- 41%	40- 11%	10- 1%	Gone	No. of groups	100- 71%	70- 41%	40- 11%	10- 1%	Gone	No. of groups	100- 71%	70- 41%	40- 11%	10- 1%	Gone
30	57	64.9	21.1	5.2	0	8.8	43	81.4	11.6	0	0	7.0	14	14.3	50.0	21.4	0	14.3
60	57	56.1	17.5	10.5	3.5	12.3	43	69.7	11.6	7.0	4.7	7.0	14	14.3	35.7	21.4	0	28.6
90	54	44.4	20.4	13.0	7.4	14.8	42	52.4	21.4	4.8	9.5	11.9	12	16.7	16.7	41.7	0	25.0
120	48	39.6	20.8	16.7	6.3	16.7	38	50.0	21.1	7.9	7.9	13.2	10	0	20.0	50.0	0	30.0
150	45	33.3	22.2	15.5	6.7	22.2	35	42.9	22.9	11.4	8.6	14.3	10	0	20.0	30.0	0	50.0
180	41	26.8	24.4	19.5	7.3	22.0	36	35.5	29.0	16.1	6.5	12.9	10	0	10.0	30.0	10.0	50.0
210	41	24.4	17.1	26.8	9.8	22.8	31	32.3	22.6	25.8	6.5	12.9	10	0	0	30.0	20.0	50.0
240	38	15.8	23.7	23.7	10.5	26.3	28	21.4	32.1	21.4	10.7	14.3	10	0	0	30.0	10.0	60.0
270	32	12.5	12.5	31.3	9.4	34.4	22	18.2	18.2	31.9	9.1	22.7	10	0	0	30.0	10.0	60.0
300	22	13.7	4.5	31.8	13.7	36.4												

levels can vary widely over just a few kilometers and ROBINETTE *et al.* (1958) recommended making counts before they become too active. Red junglefowl (*Gallus gallus*), civets and mongooses scattered or broke apart some droppings while searching for insects. Trampling and surface erosion of faeces were two lesser influences on deterioration. Sambar pellets were occasionally affected by flooding of the forest floor by heavy rains during the rainy season. Some were buried under debris or washed up to a metre from the drop site.

Ground fires in February and March eliminated many recent elephant, banteng and gaur faeces as they slowly swept through the forest. Once a dropping began to smoulder along the edges, it continued to slowly burn until it turned completely to ash. Faeces destroyed by fire were not included in the decay rate data (Tables 1, 3) because fires were not considered to be a natural form of deterioration. Their degree of occurrence depends directly on the amount of human use of the area. In most cases, ground fires had little effect on sambar pellets and only scorched their surfaces.

CONCLUSIONS

Based on results of the study, the following recommendations can be given for future dropping count census projects. In the dry season, intervals between checks of sample plots can be as long as 110 days for elephant and 50 to 60 days for sambar deer. Checks should be made before the beginning and after the close of the fire season with smaller intervals of 25 to 30 days optional during this time depending upon the amounts of dry, burnable vegetation on the forest floor and animal use. Providing there is no rainfall, checks can even be made up to one or two weeks after a plot has burned over by looking for the distinctly shaped piles of ashes that are the remains of elephant dung piles. Fires should have little effect on deer pellet groups. During the rainy season, intervals must be shortened to 40 days for elephant and to no more than 30 days for sambar. The practicality of censusing banteng and gaur by dropping counts is questionable. Accurate results will probably be obtained only in areas of high animal density and only in the dry season when 20-day periods between counts should be used. These recommendations are most applicable for areas such as western, northern

and north-eastern Thailand, which have mixed deciduous, dry dipterocarp or bamboo forests and receive less than 1500 mm of annual rainfall. Further testing should be done before dropping count censuses are made in locations with higher rainfall or evergreen forests.

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